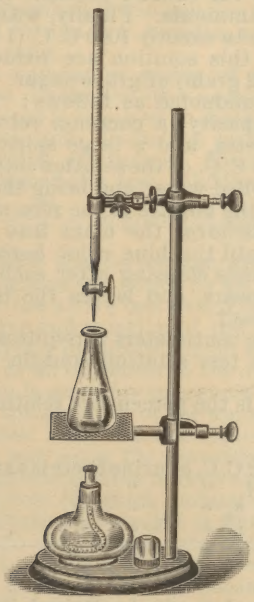
Purdy (C. W.)

QUANTITIVE TESTING FOR SUGAR IN THE URINE.

BY DR. CHARLES W. PURDY.

In order to attain the highest practical value for clinical work, a quantitive test for sugar in the urine should possess the following essential features: 1st—Accuracy. 2d—Rapidity and simplicity of application. 3d—Stability. 4th—The test should be inexpensive.



DR. PURDY'S APPARATUS FOR QUANTITIVE SUGAR TESTING.

With the above requirements in view, the writer some time since constructed and published* a quantitive test for sugar in the urine, and ample experience in its practical use has since demonstrated that it possesses the following features: 1st—It enables one to determine the quantity of sugar in a given sample of urine in about five minutes. 2d—It is accurate even to fractions of grains, as any one may readily prove by submitting to it solutions of grape sugar of known and accurately measured strength. 3d—The stability of the test is such

* Treatise on Diabetes, 1890.

that it may be kept on hand for months without impairing its qualities 4th—The test is simple in application, the apparatus required being of the most common order.

In response now to numerous requests, and in order to facilitate both practical work and laboratory teaching, I have accurately standardized the test solution in the metric system as follows :

Cupric Sulphate, C. P.	- -	4.742 Grams.
Caustic Potash, C. P.	- -	23.50 "
Strong Ammonia, U.S.P. (sp. gr. .09)		450 C. C.
Glycerin, C. P. - - - -		38 " "
Distilled Water,	- -	to 1000 " " (one litre).

Prepare by dissolving the cupric sulphate and glycerine in 200 C. C. of distilled water with the aid of gentle heat. In another 200 C. C. of distilled water dissolve the caustic potash. Mix the two solutions, and when cold add the ammonia. Finally, with distilled water bring the volume of the whole to exactly 1000 C. C. (1 litre).*

Thirty-five C. C. of this solution are reduced upon boiling by exactly 2 centigrams (.02 gram) of grape sugar.

The test should be conducted as follows : Have on hand a glass flask (150 or 200 C. C. capacity), a common retort stand, a 10 C. C. or 20 C. C. graduated burette, and a large spirit lamp.† Proceed by accurately measuring 35 C. C. of the solution into the flask, dilute with about 2 volumes of distilled water, and bring the whole *thoroughly* to the boiling point. Fill the burette to the zero mark with the urine to be tested, and *slowly discharge* the urine into the *boiling* test solution—drop by drop—until the blue color *begins to fade;* then *still more slowly*—3 to 5 seconds elapsing after each drop—until the blue color completely disappears, and leaves the test solution perfectly *transparent and colorless.*‡

The number of cubic centimeters it requires to discharge the blue color in 35 C. C. of the test solution contain exactly 2 centigrams (.02 gram) of sugar.

The following, then, is the percentage relationship of reduction of the test :

If 35 C. C. be reduced by	2	C. C.	of urine	there is exactly	1.	per cent.	sugar.
" "	"	"	1	"	"	"	"	2.	"	"
" "	"	"	¾	"	"	"	"	3.	"	"
" "	"	"	½	"	"	"	"	4.	"	"
" "	"	"	¼	"	"	"	"	8.	"	"

If absolute accuracy of results be desired, it is better to dilute the urine to be tested with 2 volumes of distilled water, and divide the product by 3, especially if the percentage of sugar be high.

* It is important that the cupric sulphate and glycerin be chemically pure. The ammonia should be U. S. P. strength—sp. gr. 0.9—that sold as chemically pure strong ammonia water is best.

† Messrs. E. H. Sargent & Co., of 108 Wabash Ave., prepare and keep in stock the above solution, as well as the apparatus required for testing.

‡ It will be noted after testing, that upon standing some time, the test solution slowly resumes the blue color again. This is due to absorption of oxygen from the atmosphere, which re-forms the blue protoxide of copper from the cupric suboxide held in solution by the ammonia. This should not be mistaken for imperfect reduction, or defect in the test solution.

Those who still prefer to work with the English weights and measures, may obtain the same accuracy of results by using the following formula and methods:

Sulphate of Copper, C. P., -	44 Grains.
Caustic Potash, C. P., - -	214 "
Strong Ammonia, U.S.P. (sp. gr. 0.9)	9 Fluid Ounces.
Glycerine, C. P., - - -	6 Drachms.
Distilled Water, - - -	to 20 Ounces.

Prepare by dissolving the sulphate of copper and glycerine in 4 ounces of distilled water, with the aid of gentle heat. In another 4 ounces of distilled water dissolve the caustic potash. Mix the two solutions, and when cold add the ammonia. Finally, with distilled water bring the volume of the whole to exactly 20 fluid ounces.

Ten drachms of the above solution are reduced upon boiling by exactly one-third ($\frac{1}{3}$) grain of grape sugar. The test is conducted precisely as already described in the metric system, save that a minim burette is substituted for the C. C. burette, and the result is reckoned in grains instead of grams.

To determine the number of grains of sugar per ounce in any given sample of urine, divide 480 (the number of grains per ounce) by the number of minims it required to discharge the blue color in 10 drachms of the test solution; divide the product by 3 and the result is the number of grains per ounce. *Example:* If 16 minims of urine reduce 10 drachms of the test solution there are 10 grains of sugar per ounce—$\frac{480}{16} = \frac{30}{3} = 10$ grains of sugar.

If it be desired to know the percentage amount of sugar present, divide the number of grains per ounce by 4.8.

The advantages of the above test over Fehling's solution are that it obviates the defective end reaction of the latter, as well as its well known property of rapidly deteriorating on keeping.

It has been stated as an objection to the ammonio-cupric test that the "ratio of reduction is seriously influenced by the amount of fixed alkali present and by the strength of the ammonia." This statement is chemically untenable. The ratio of reduction of cupric salts by grape sugar depends *not upon the quantity* of alkali present, but upon the *quality*, and moreover it is in each case a fixed ratio. Thus, in Pavy's standard solution in which potassium is employed as the alkali, the ratio of reduction by weight is 1 of sugar to 6.666 of cupric sulphate. In Fehling's solution in which sodium is employed the ratio of reduction is 1 of sugar to 6.9278 of cupric sulphate. In the ammonio-cupric test in which both potassium and ammonium are employed, the ratio of reduction is 1 of sugar to 8.3 of cupric sulphate. The ratio of reduction in the ammonio-cupric test as here brought forward is as *fixed* as that in Fehling's or any other alkaline solution of cupric sulphate; furthermore, if it contained 200 per cent. more ammonia than specified in the formula it would not change the ratio of reduction. The effect of adding a *very great excess* of alkali to the copper test, whether volatile or fixed, would only be that of somewhat *slowing* the reduction process, without in the least altering the absolute ratio. This instead of impairing the test, actually tends to improve it, since it enables one more deliberately, and consequently with more precision, to find the exact point of complete reduction.

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